

Aquarius Instrument to Aquarius Ground System Interface Document

1. Introduction

This document is an informal compilation of information extracted from the Aquarius High Rate Data Format document (delivered by the instrument team with the Command and Telemetry Dictionaries), SAC-D Subsystem description documents and ICDs, and CONAE Ground System descriptions and ICDs. It is intended to describe the complete science packet data flow and the various formats of that data as it is transferred through the entire system from the Aquarius instrument to the Aquarius Data Processing System (ADPS).

The purpose of documenting the data flow and formats is to enable ADPS developers to have the information required to correctly assemble and process Aquarius Level 1a data from the raw (Level 0) data received from the CONAE Data Archive and Distribution System (DADS).

The AQ/SACD-CONAE MOC system design concept is that the files delivered to the ADPS from the DADS will be identical in content to the data stream that flows from the Aquarius ICDS subsystem downlink port. However, the data is internally manipulated by both SACD and the CONAE MOC during the downlink and capture process and errors in that process may be reflected in the final science data received by the ADPS. In order to understand the potential impacts of errors at various points during the transmission, the full data flow must be identified.

The Aquarius instrument data elements traced are:

- Radiometer science (3 radiometers)
- Scatterometer science
- Radiometer telemetry
- Scatterometer telemetry
- Other Aquarius instrument telemetry (ATC, ICDS, APDS)

Only data transferred through the SAC-D Mass Memory Unit is traced in this document. Realtime data does not include science data and so does not pertain to this topic.

References:

AQ_hr_data_v6g.xls, Alex Murray; instrument high rate (science and telemetry) format.

Radiometer to ICDS ICD, Josh Forgione and Mimi Paller

Scatterometer to ICDS ICD, xx and Mimi Paller

COMMdes.doc; ICDS Communications Board description, Mimi Paller

0830-SCIG-GYEIS-001-A.pdf, INVAP, Service Platform to instrument ICD
SAC-D Mass Memory Subsystem description document, INVAP
CONAE Ground System PDR presentation, Manfred Pacher, CONAE
CONAE-AQ GS ICD, Manfred Pacher, CONAE
Aquarius Ground System Science Data Processing PDR presentation, Gene Feldman

2. Data Flow Overview

The total system flow is traced through these elements:

- Radiometer and Scatterometer to the ICDS
- ICDS through the Service Platform to the SACD Mass Memory (CCSDS formatter)
- Mass Memory to the X-Band transmitter to the Ground Station X-Band Rx antenna
- X-Band Rx antenna to CCSDS unwrapping software in the CONAE MOC
- CONAE MOC to the Data Archive and Distribution System
- DADS to the Aquarius Ground System ADPS as Level 0 data (again, where does it reside?)

The concept is to follow the data at the bit-stream, contiguous transfer frame, separated transfer frame and file formats.

The data is transferred as a bit stream throughout the instrument to the Mass Memory. It is formatted into transfer frames at the Mass Memory. From the Mass Memory to the ground storage device, it is physically a bit-stream, but virtually a transfer frame. From the ground storage device it is de-formatted, then consolidated into S/P and instrument specific files. It is maintained as a file when transferred to the ADPS. Once at the ADPS, associated files may be consolidated into a single file (instrument, S/P, and ancillary data files, for example for a single download, may be consolidated into a single file).

Overlapping data may be captured at the Ground Stations. Level 0 to Level 1a processing therefore also includes time sorting of data and the discard of overlaps. (Is quality sorting also done here?)

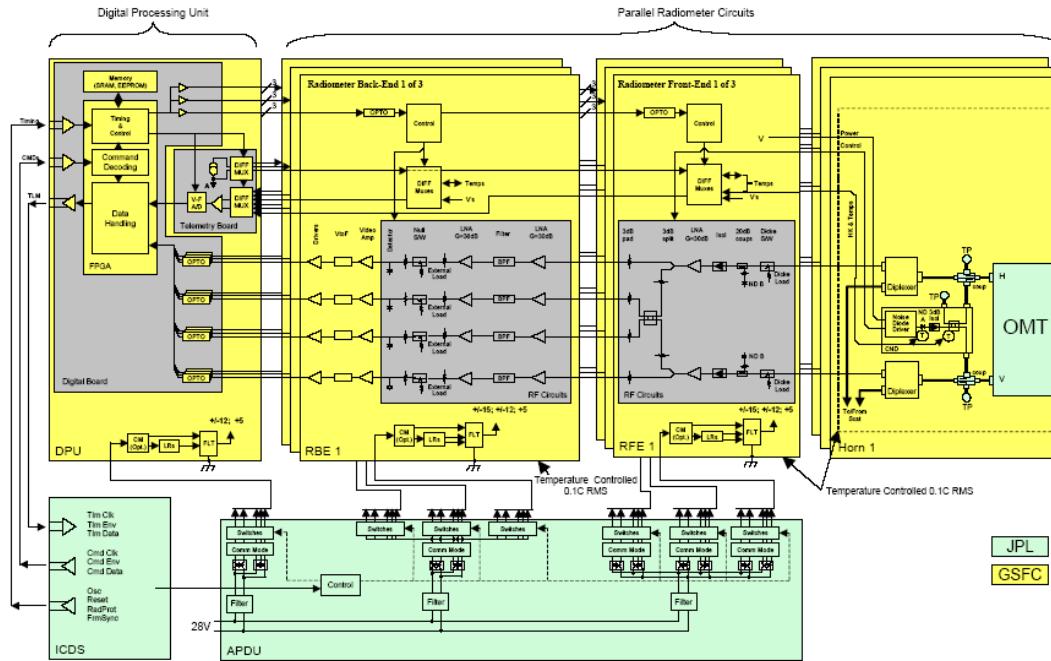
3. Data Formats by Element

a. Radiometer

The Radiometer Digital Processing Unit (DPU) commands the switch positions of the three radiometers within the Aquarius instrument. Switch position commands control the inputs to the radiometers:

- antenna signal
- Correlated Noise Diode (CND)
- Dicke Switch Load (DL)
- Internal Noise Diode with the Dicke Load (ND)
- Internal Noise Diode with the antenna signal (ND*)
- Zero Offset (blank)

Figure 1-1: Aquarius Block Diagram



The antenna signal is the science data of interest. The noise diodes, Dicke Switch Load, and zero offset (zero input voltage to the radiometer) are utilized for instrument calibration.

As can be seen in the Aquarius Block Diagram (Figure 1-1), the antenna signal consists of both a horizontal and vertical polarization signal. Each polarization has its own physical channel that begins at the output of the Orthomode Transducer (OMT).

The Correlated Noise Diode (CND) is located at the front of the channels so that it can be used to calibrate each entire path.

Now each path passes through its respective diplexer (that allows signal to be coupled into the Scatterometer) and enters the Radiometer Front End. Here the signals are received after passing through a Dicke Switch and, if commanded, an Internal Noise Diode.

The Dicke Switch provides a means of emulating a very low-noise receiver. It is a switch that rapidly changes inputs from the antenna to its own precisely temperature controlled

noise diode. By comparing the incoming antenna signal to this very low noise diode rather than directly comparing the signal to the receiver's noise floor, the Dicke Switch greatly enhances the signal to noise ratio at the receiver front-end.

At this point in the paths, each channel is divided. The new signals serve as inputs to the +45 degree and -45 degree polarization channels. Now a total of four channels exist for each radiometer: Horizontal, vertical, +45, -45.

A Zero Offset is available for each of these four channels.

The outputs of these four channels are read into the DPU as science data in the following order (TBD):

- Radiometer 1 Horizontal
- Radiometer 1 Vertical
- Radiometer 1 +45
- Radiometer 1 - 45
- Radiometer 2 Horizontal
- Radiometer 2 Vertical
- Radiometer 2 +45
- Radiometer 2 - 45
- Radiometer 3 Horizontal
- Radiometer 3 Vertical
- Radiometer 3 +45
- Radiometer 3 - 45

The radiometer functions as a State Machine. This means that rather than issuing individual commands with full flexibility, the DPU sends all the commands required to place each channel into the desired state. Each state equates to a particular configuration of switch positions and results in the generation of a specific science data set.

Note: The time allotted to command a state is 1 msec within a Pulse Repetition Interval (PRI) of 10 msecs. The first millisecond is reserved for reception and execution of the DPU switching commands. The remaining 9msecs is reserved for reading the resulting signals.

The potential states for each channel are:

- The CND can be switched in (vs. the antenna signal),
- The Dicke Switch can be held in the Load position,
- The Internal Noise Diode can be switched in (in combination either with the signal input from the antenna or from the Dicke Load), or
- All four channel inputs can be circumvented by commanding the Zero Offset into the paths.

Note: All three radiometers are commanded to the same state for a given channel. For example, the horizontal channels for radiometers 1, 2, and 3 will always be in the same state.

When the Dicke Switch is commanded to the Load position by the DPU, the rapid switching it normally does between the antenna and the Dicke Load is replaced by fixing the switch position on the Dicke Load.

The DPU command sequences are controlled by the on-board Look Up Table (LUT). Up to eight LUTs may be available for selection via ground command. (TBD). There will be four (TBD) pre-programmed LUTs and four (TBD) ground-programmable LUTs.

Each LUT issues switch position (state) commands in two subsets of 12 steps per subset. The first subset of 12 steps is issued 10 times. The second subset of 12 steps is issued 2 times.

The default LUT issues the following radiometer switch position commands in the sequence shown:

	V	H
Step 1	A	A
Step 2	A	A
Step 3	A	A
Step 4	A	A
Step 5	A	A
Step 6	A	A
Step 7	A	A
Step 8	CND	CND
Step 9	DL	DL
Step 10	ND	DL
Step 11	ND	ND
Step 12	DL	ND

These 12 steps are repeated 10 times for a total of 120 steps. Then the DPU commands these states in the sequence shown:

	V	H
Step 121	A	A
Step 122	A	A
Step 123	A	A
Step 124	A	A
Step 125	A	A
Step 126	A	A
Step 127	A	A
Step 128	CND	CND
Step 129	ZERO	ZERO

Step 130	ND*	DL
Step 131	ND*	ND*
Step 132	DL	ND*

These twelve sequences are repeated twice. Thus the final steps are Steps 133 – 144 (not shown explicitly here.)

A = Antenna signal

V = Radiometer vertical polarization channel (antenna)

H = Radiometer horizontal polarization channel (antenna)

CND = Correlated Noise Diode

DL = Dicke Load

ND = Internal Noise Diode with the Dicke Load

ND* = Internal Noise Diode with the antenna signal

Z = Zero Offset

These commanded states generate four channels of data per radiometer. The complete data set received by the DPU with each full cycle (the two subcycles) is:

Step 121	A	A	A	A	A	A	A	A	A	A	A	A	A
Step 122	A	A	A	A	A	A	A	A	A	A	A	A	A
Step 123	A	A	A	A	A	A	A	A	A	A	A	A	A
Step 124	A	A	A	A	A	A	A	A	A	A	A	A	A
Step 125	A	A	A	A	A	A	A	A	A	A	A	A	A
Step 126	A	A	A	A	A	A	A	A	A	A	A	A	A
Step 127	A	A	A	A	A	A	A	A	A	A	A	A	A
Step 128	CND												
Step 129	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
Step 130	ND*	DL	DL										
Step 131	ND*												
Step 132	DL	ND*	ND*										

R1 = Radiometer 1

R2 = Radiometer 2

R3 = Radiometer 3

+ = Radiometer +45 degree polarization channel (antenna)

- = Radiometer -45 degree polarization channel (antenna)

The DPU then averages selected data according to a scheme that applies permanently to each Step combination. The averaged data set output by the DPU and including the radiometer telemetry packet and header information is as follows:

Item #	field	subcycle #	# of bits ea.	# of ch	total # of bits	Subcycle #7					
						40	SAvg1	7	16	12	192
Radiometer:											
1	Header		16	1	16	41	SAvg2	7	16	12	192
2	telemetry (1/4 of frame)		400	1	400	42	SAvg3	7	16	12	192
3	Radiometer Status		80		80	43	SAvg4	7	16	12	192
Subcycle #1						44	SAvg5	7	16	12	192
4	SAvg1	1	16	12	192	45	SAvg6	7	16	12	192
5	SAvg2	1	16	12	192	Subcycle #8					
6	SAvg3	1	16	12	192	46	SAvg1	8	16	12	192
7	SAvg4	1	16	12	192	47	SAvg2	8	16	12	192
8	SAvg5	1	16	12	192	48	SAvg3	8	16	12	192
9	SAvg6	1	16	12	192	49	SAvg4	8	16	12	192
Subcycle #2						50	SAvg5	8	16	12	192
10	SAvg1	2	16	12	192	51	SAvg6	8	16	12	192
11	SAvg2	2	16	12	192	Subcycle #9					
12	SAvg3	2	16	12	192	52	SAvg1	9	16	12	192
13	SAvg4	2	16	12	192	53	SAvg2	9	16	12	192
14	SAvg5	2	16	12	192	54	SAvg3	9	16	12	192
15	SAvg6	2	16	12	192	55	SAvg4	9	16	12	192
Subcycle #3						56	SAvg5	9	16	12	192
16	SAvg1	3	16	12	192	57	SAvg6	9	16	12	192
17	SAvg2	3	16	12	192	Subcycle #10					
18	SAvg3	3	16	12	192	58	SAvg1	10	16	12	192
19	SAvg4	3	16	12	192	59	SAvg2	10	16	12	192
20	SAvg5	3	16	12	192	60	SAvg3	10	16	12	192
21	SAvg6	3	16	12	192	61	SAvg4	10	16	12	192
Subcycle #4						62	SAvg5	10	16	12	192
22	SAvg1	4	16	12	192	63	SAvg6	10	16	12	192
23	SAvg2	4	16	12	192	Subcycle #11					
24	SAvg3	4	16	12	192	64	SAvg1	11	16	12	192
25	SAvg4	4	16	12	192	65	SAvg2	11	16	12	192
26	SAvg5	4	16	12	192	66	SAvg3	11	16	12	192
27	SAvg6	4	16	12	192	67	SAvg4	11	16	12	192
Subcycle #5						68	SAvg5	11	16	12	192
28	SAvg1	5	16	12	192	69	SAvg6	11	16	12	192
29	SAvg2	5	16	12	192	Subcycle #12					
30	SAvg3	5	16	12	192	70	SAvg1	12	16	12	192
31	SAvg4	5	16	12	192	71	SAvg2	12	16	12	192
32	SAvg5	5	16	12	192	72	SAvg3	12	16	12	192
33	SAvg6	5	16	12	192	73	SAvg4	12	16	12	192
Long' Accumulations:						74	SAvg5	12	16	12	192
34	SAvg1	6	16	12	192	75	SAvg6	12	16	12	192
35	SAvg2	6	16	12	192	Subcycle #6					
36	SAvg3	6	16	12	192	76	LAvg1	1-10	16	12	192
37	SAvg4	6	16	12	192	77	LAvg2	1-10	16	12	192
38	SAvg5	6	16	12	192	78	LAvg3	1-10	16	12	192
39	SAvg6	6	16	12	192	79	LAvg4	1-10	16	12	192
						80	LAvg5	11-12	16	12	192
						81	LAvg6	11-12	16	12	192
						82	LAvg7	11-12	16	12	192
						83	LAvg8	11-12	16	12	192
Rad Totals: # bits 15856 # bytes 1982											

b. Scatterometer

The Scatterometer transmits an L-Band pulse through each of the Aquarius feeds. The Scatterometer pulse echo is then received by the Scatterometer and digitized by the ICDS into a 16 bit measurement. The transmitted pulses are also looped back into the

Scatterometer receiver, attenuated, and digitized by the ICDS. Both the echo and the transmit (loopback) measurements are downlinked to the ground in the Scatterometer science packet, but the loopback measurements are averaged.

The Scatterometer timing is synchronized with the Radiometer within each PRI, but the cycles are not in phase. The Radiometer cycle is 0.12 seconds (12 PRIs); the Scatterometer is 0.18 seconds (18 PRIs).

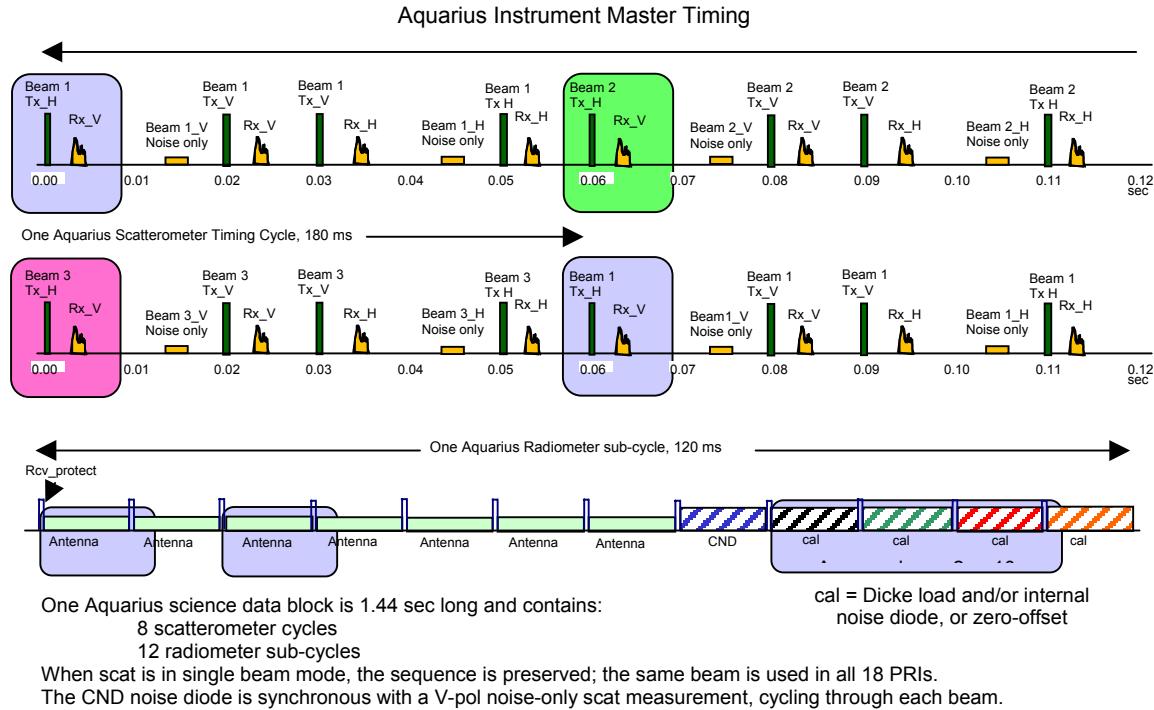


Figure X.X Scatterometer and Radiometer Relative Timing.

During the Scatterometer cycle of 18 PRIs, pulses are transmitted and received in a fixed sequence through each of the three beams and two polarizations as follows:

Step #	Step start Time (mSec)	Tx Channel	Rx Channel
1	0	H1	V1
2	10	no Tx	Noise V1
3	20	V1	V1
4	30	V1	H1
5	40	no Tx	Noise H1
6	50	H1	H1
7	60	H2	V2
8	70	no Tx	Noise V2
9	80	V2	V2
10	90	V2	H2
11	100	No Tx	Noise H2
12	110	H2	H2

13	120	H3	V3
14	130	No Tx	Noise V3
15	140	V3	V3
16	150	V3	H3
17	160	No Tx	Noise H3
18	170	H3	H3

Table X.X Sequence for a Scatterometer science block (180 ms or 18 PRI)

The "Tx Channel" or Loopback data is averaged over eight 180 ms cycles. The eight cycles of receive data and averaged loopback data make up one science packet. The resulting 312 byte Scatterometer science packet is formatted as:

field	subcycle #	# of bits ea.	total # of bits	field	subcycle #	# of bits ea.	total # of bits				
<i>and so forth</i>											
B3VH pwr	7	16	16	B3nH pwr	7	16	16				
B3HH pwr	7	16	16	subcycle header	8	8	8				
B1HV pwr	8	16	16	B1nV pwr	8	16	16				
B1VV pwr	8	16	16	B1HH pwr	8	16	16				
B1VH pwr	8	16	16	B2HV pwr	8	16	16				
B1nH pwr	8	16	16	B2nV pwr	8	16	16				
B1HH pwr	8	16	16	B2VV pwr	8	16	16				
B2HV pwr	8	16	16	B2VH pwr	8	16	16				
B2nV pwr	8	16	16	B2nH pwr	8	16	16				
B2VV pwr	8	16	16	B2HH pwr	8	16	16				
B2VH pwr	8	16	16	B3HV pwr	8	16	16				
B2nH pwr	8	16	16	B3nV pwr	8	16	16				
B2HH pwr	8	16	16	B3VV pwr	8	16	16				
B3HV pwr	8	16	16	B3VH pwr	8	16	16				
B3nH pwr	8	16	16	B3nH pwr	8	16	16				
B3HH pwr	8	16	16	B3HH pwr	8	16	16				
subcycle header	2	8	8	<i>Loopback measurements</i>							
B1HV pwr	2	16	16	B1HV pwr	1-8	16	16				
B1nV pwr	2	16	16	B1nV pwr	1-8	16	16				
B1VV pwr	2	16	16	B1VV pwr	1-8	16	16				
B1VH pwr	2	16	16	B1VH pwr	1-8	16	16				
B1nH pwr	2	16	16	B1nH pwr	1-8	16	16				
B1HH pwr	2	16	16	B1HH pwr	1-8	16	16				
B2HV pwr	2	16	16	B2HV pwr	1-8	16	16				
B2nV pwr	2	16	16	B2nV pwr	1-8	16	16				
B2VV pwr	2	16	16	B2VV pwr	1-8	16	16				
B2VH pwr	2	16	16	B2VH pwr	1-8	16	16				
B2nH pwr	2	16	16	B2nH pwr	1-8	16	16				
B2HH pwr	2	16	16	B2HH pwr	1-8	16	16				
B3HV pwr	2	16	16	B3HV pwr	1-8	16	16				
B3nV pwr	2	16	16	B3nV pwr	1-8	16	16				
B3VV pwr	2	16	16	B3VV pwr	1-8	16	16				
B3VH pwr	2	16	16	B3VH pwr	1-8	16	16				
B3nH pwr	2	16	16	B3nH pwr	1-8	16	16				
B3HH pwr	2	16	16	B3HH pwr	1-8	16	16				
subcycle header	3	8	8	B1HV DC	1-8	16	16				
B1HV pwr	3	16	16	B1NV DC	1-8	16	16				
B1nV pwr	3	16	16	scat telem			312				
<i>and so forth</i>											

Table X.X Scatterometer science data format.

The final two readings are the B1HV DC and B1NV DC voltages within the Loopback measurements. These are [TBD].

c. ICDS

As described in sections a and b, the ICDS receives and formats the science measurements from the Radiometer and Scatterometer. It also receives Housekeeping Telemetry measurements from them as well as from the Automatic Temperature Control unit (ATC), the Aquarius Power Distribution Unit (APDU), selected antenna and mechanical elements, and from itself. The complete block format is shown in Table X.X.

FORMAT OF THE AQUARIUS SCIENCE BLOCK

10/21/05

NOTES:

- All multi-byte values are big-endian; MSB first, and MS-bit (bit N-1 for a word of N bits) is first
- Telemetry Item (or packet) definitions, referenced in the Type column, are contained in the Telemetry Dictionary
- The Telemetry Item packets, e.g. Antenna Telemetry Item, are defined in the telemetry dictionary, and their sizes in this table must be kept current with the definitions there.

Section	Field or Group	Type	Size (bytes)	Byte Offset	Definition/Notes
Header	sync word	integer	4	0	0 constant: 0xdeadbeef
	GPS time tag	integer	4	4	4 TAI, Epoch Jan 1 1980, midnight
	time tag offset	integer	4	8	8 Units of 10usec, range: [0-100000]
	antenna telemetry	Antenna Telemetry Item	5	12	
	ICDS processing status	ICDS Processing Status Item	11	17	
	ICDS engineering telem	ICDS Engineering Item	20	28	
	mechanical telemetry	Mechanical Thermal Item	71	48	
	ADPU telemetry	ADPU Telemetry Item	6	119	
Science Data	ATC telemetry	ATC Telemetry Item	45	125	One channel of ATC telemetry
	scatterometer HKT	Scatterometer Telemetry Item	39	170	Scatterometer housekeeping
	scatterometer science data	Scatterometer Block	336	209	See NblockO worksheet. See NblockO worksheet. This includes
Footer	radiometer science data	Radiometer Block	1982	545	radiometer telemetry
	checksum	integer	2	2527	2529

SCI BLOCK SIZE:

2529

2529

Table X.X Aquarius Instrument Science Block generated by the ICDS every 1.44 seconds.

The first items in the Aquarius Science Block, the sync word, the GPS time tag, and the time-tag offset, are described in Table X.X.

The antenna telemetry, Item ID 0x60, provides antenna deployment switch positions and thermal data. These five bytes are:

Name	# of bits	Description
joint1_stowed	1	limit switch
joint2_stowed	1	limit switch
joint1_deployed_A	1	limit switch redundant limit
joint1_deployed_B	1	switch
joint2_deployed_A	1	limit switch redundant limit
joint2_deployed_B	1	switch
joint1_tempA	8	
joint1_tempB	8	
joint2_tempA	8	
joint2_tempB	8	

The ICDS, Item ID 0x51, provides 10 bytes of processing status and 19 bytes of engineering (thermal and electrical) telemetry:

Name	# of bits	Description
GPS at last boot	16	middle 2 bytes of GPS time at last boot.
command count	16	cmd received counter
last command id	16	last command received ID
last_block_number	32	last science block produced
ICDS +5v	8	analog
ICDS +15v	8	analog
ICDS -15v	8	analog
sci ADC voltage	8	analog
sci ADC temperature	8	analog
ICDS chassis temperature	8	near ATC boards – analog
ICDS rad6000 temperature	8	analog
ICDS telem board cal resister 1	16	analog
ICDS telem board cal resister 1	16	analog
ICDS telem board cal resister 1	16	analog
ICDS telem board cal resister 1	16	analog
register address	16	address of ICDS subassy. register reported in next field
register value	16	value of 1 ICDS subassy register
radiometer FIFO flag	1	to be moved
radiometer FIFO	1	to be moved
underflow=1/overflow	1	to be moved
	234	
	232	

Mechanical telemetry, Item ID 0x80, 69 bytes, concerns the thermal points for the antenna elements:

# of bits	Description
16	OMT1 H-probe temp
16	OMT1 V-probe temp
16	OMT2 H-probe temp
16	OMT2 V-probe temp
16	OMT3 H-probe temp
16	OMT3 V-probe temp
8	dplxr to SFE coax H1
8	dplxr to SFE coax H2
8	dplxr to SFE coax H3
8	dplxr to SFE coax V1
8	dplxr to SFE coax V2
8	dplxr to SFE coax V3
16	diplexer 1H
16	diplexer 1V
16	diplexer 2H
16	diplexer 2V
16	diplexer 3H

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16 diplexer 3V
16 coupler 1H
16 coupler 1V
16 coupler 2H
16 coupler 2V
16 coupler 3H
16 coupler 3V
8 CND1
8 CND2
8 CND3
16 reflector1
16 reflector2
16 reflector3
16 reflector4
16 reflector5
16 reflector6
16 reflector7
16 reflector8
16 reflector9
16 feed1
16 feed2
16 feed3

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552
552.00

Next follows the APDU telemetry, Item ID 0x68, 6 bytes:

Name	# of bits	Description
APDU_temp1	8	APDU Temp1
APDU_temp2	8	APDU Temp2
APDU_temp3	8	APDU Temp3
APDU_temp4	8	APDU Temp4
APDU_temp5	8	APDU Temp5
APDU_v_RFE	1	RFEs voltages health
APDU_v_scat	1	scat voltages health
APDU_v_ICDS_ATC	1	ICDS voltages health
APDU_v_RBE_DPU	1	RBE and DPU voltages health

44
48

The ATC telemetry, Item ID 0x70, provides 45 bytes for each of 4 ATC channels.

Field Name	Size (bits)
ATC_channel_ID	3
PRT1 prime ctrl	16
PRT2 redundant ctrl	16
PRT3 H-probe coax, SFE	16
PRT4 V-probe coax, RBE	16
PRT5 OMT neck, SFE	16
PRT6 OMT structure, SBE	16
Heater Power min	16
Heater Power max	16
Heater Power avg	16
Temp Control Setpoint echo	24
PID Control param echo: proportion	24
PID Control param echo: integral	24
PID Control param echo: derivative	24
Control sensor select echo	1
control mode (power or temp) echo	1
heater power setpoint echo	24
temperature offset echo	24
ADC Mode Bytes 1 MSBs	24
ADC Mode Bytes 2 MSBs	24
Caution and Warning	16

The Scatterometer Housekeeping Telemetry follows, ID 0xa0, 39 bytes. After the Scatterometer HKT, the Scatterometer science packet is inserted as described in section 1.b.

# of bits	Description
16	loopback B1HV DC
16	loopback B1HV pwr
2	FIFO errors
1	SSPA LVPS overcurrent flag
1	SSPA LVPS bus undervoltage flag
1	SBE PLM 1 Lock (960)
1	SBE PLM 2 Lock (956)
1	SCG latchup prime
1	SCG latchup redun
8	LVPS temp
8	SSPA RF temp
8	SCG temp
8	SBE LNA temp
8	SBE Tx Chain temp

8 SBE Rx Chain temp
 8 SFE Tx load
 16 SBE step attenuator temp
 16 SFE loopback attenuator temp
 16 SFE loopback switch temp
 16 SFE beam switch temp
 8 SFE Tx power monitor
 8 SFE 15N voltage monitor
 8 SBE PLM 1 tuning voltage (960)
 8 SBE PLM 2 tuning voltage (956)
 8 SBE 8MHz Stalo Output Power Level
 8 SBE 16 MHz Power Level
 8 SBE PLM1 Power Level (960)
 8 SBE PLM2 Power Level (956)
 8 SBE Rx-Lo Power Level (1256)
 8 SBE Tx Exciter Power Mon
 8 LVPS Converter Current
 8 SSPA output stage voltage
 8 SSPA intermediate stage voltage
 8 SSPA input stage voltage
 8 SFE +5V monitor
 8 SCG +5V monitor
 8 SBE +5V monitor
 8 SBE +12V monitor (non switched)
 8 SBE +12V monitor (switched)

312

Following the Scatterometer HKT and science packets, the Radiometer HKT and science packets are inserted. The Radiometer HKT packet is as shown and the science packet that follows is as described in section 1.a. Note that only one of HKT packets 0 – 3 are transmitted with a Radiometer science packet. Thus a full frame of telemetry requires the transmission of 4 science blocks. Each Radiometer science/telemetry block is 1982 bytes.

Table 3-7: Housekeeping Packet #0			Item ID 0x90
Item #	Subsystem	Size - bits	Description
1	DPU	4	Block Counter
RFE #1 Standard Housekeeping			
2	RFE1	8	CND1-NDCurrent
3	RFE1	10	CND1-NDTemp
4	RFE1	10	CND1-HybridTemp
5	RFE1	10	RFE1-HNDTemp
6	RFE1	8	RFE1-HNDCurrent
7	RFE1	10	RFE1-VNDTemp
8	RFE1	8	RFE1-VNDCurrent
9	RFE1	10	RFE1-LNAHTemp
10	RFE1	10	RFE1-LNAVTemp
11	RFE1	10	RFE1-PwrTemp

12	RFE1	10	RFE1-BDTemp1
13	RFE1	10	RFE1-BDtemp2
14	RFE1	8	RFE1-15VP
15	RFE1	8	RFE1-15VN
16	RFE1	8	RFE1-12VP
17	RFE1	8	RFE1-12VN
18	RFE1	8	RFE1-8VP
19	RFE1	8	RFE1-5VP
10mK Temperatures: Set #A			
20	RFE1	12	RFE1-DkSwVaTemp+
21	RFE1	12	RFE1-DkSwVaTemp-
22	RFE1	12	RFE1-DkSwHaTemp+
23	RFE1	12	RFE1-DkSwHaTemp-
24	RFE2	12	RFE2-DkSwVaTemp+
25	RFE2	12	RFE2-DkSwVaTemp-
26	RFE2	12	RFE2-DkSwHaTemp+
27	RFE2	12	RFE2-DkSwHaTemp-
28	RFE3	12	RFE3-DkSwVaTemp+
29	RFE3	12	RFE3-DkSwVaTemp-
30	RFE3	12	RFE3-DkSwHaTemp+
31	RFE3	12	RFE3-DkSwHaTemp-
DPU Standard Housekeeping:			
32	DPU	10	DPU-BD1-Temp
33	DPU	10	DPU-BD2-Temp
34	DPU	10	DPU-ISrcTemp
35	DPU	12	DPU-RefV
36	DPU	8	DPU-12VP
37	DPU	8	DPU-12VN
38	DPU	8	DPU-5VP
39		24	Spare
	Total:	400	Bits

Bits Sent In

HKT: 376

Size in Bytes:

47

Table 3-8: Housekeeping Packet #1			Item ID 0x91
Item #	Subsystem	Size - bits	Description
1	DPU	4	Block Counter
RFE #2 Standard Housekeeping			
2	RFE2	8	CND2-NDCurrent
3	RFE2	10	CND2-NDTemp
4	RFE2	10	CND2-HybridTemp
5	RFE2	10	RFE2-HNDTemp
6	RFE2	8	RFE2-HNDCurrent

7	RFE2	10	RFE2-VNDTemp
8	RFE2	8	RFE2-VNDCurrent
9	RFE2	10	RFE2-LNAHTemp
10	RFE2	10	RFE2-LNAVTemp
11	RFE2	10	RFE2-PwrTemp
12	RFE2	10	RFE2-BDTemp1
13	RFE2	10	RFE2-BDtemp2
14	RFE2	8	RFE2-15VP
15	RFE2	8	RFE2-15VN
16	RFE2	8	RFE2-12VP
17	RFE2	8	RFE2-12VN
18	RFE2	8	RFE2-8VN
19	RFE2	8	RFE2-5VP
RFE #3 Standard Housekeeping			
20	RFE3	8	CND3-NDCurrent
21	RFE3	10	CND3-NDTemp
22	RFE3	10	CND3-HybridTemp
23	RFE3	10	RFE3-HNDTemp
24	RFE3	8	RFE3-HNDCurrent
25	RFE3	10	RFE3-VNDTemp
26	RFE3	8	RFE3-VNDCurrent
27	RFE3	10	RFE3-LNAHTemp
28	RFE3	10	RFE3-LNAVTemp
29	RFE3	10	RFE3-PwrTemp
30	RFE3	10	RFE3-BDTemp1
31	RFE3	10	RFE3-BDtemp3
32	RFE3	8	RFE3-15VP
33	RFE3	8	RFE3-15VN
34	RFE3	8	RFE3-12VP
35	RFE3	8	RFE3-12VP
36	RFE3	8	RFE3-12VN
37	RFE3	8	RFE3-5VP
38		72	Spare
Total:		400	Bits
		328	
		41	

Table 3-9: Housekeeping Packet #2		Item ID 0x92	
Item #	Subsystem	Size - bits	Description
1	DPU	4	Block Counter
10mK Temperatures: Set #B			
2	RFE1	12	RFE1-DkSwVbTemp+
3	RFE1	12	RFE1-DkSwVbTemp-
4	RFE1	12	RFE1-DkSwHbTemp+
5	RFE1	12	RFE1-DkSwHbTemp-
6	RFE2	12	RFE2-DkSwVbTemp+

7	RFE2	12	RFE2-DkSwVbTemp-
8	RFE2	12	RFE2-DkSwHbTemp+
9	RFE2	12	RFE2-DkSwHbTemp-
10	RFE3	12	RFE3-DkSwVbTemp+
11	RFE3	12	RFE3-DkSwVbTemp-
12	RFE3	12	RFE3-DkSwHbTemp+
13	RFE3	12	RFE3-DkSwHbTemp-
RBE #1 Standard Housekeeping			
14	RBE1	8	RBE1-15VP
15	RBE1	8	RBE1-15VN
16	RBE1	8	RBE1-12VP
17	RBE1	8	RBE1-12VN
18	RBE1	8	RBE1-8VP
19	RBE1	8	RBE1-5VP
20	RBE1	10	RBE1-LNA1-1-Temp
21	RBE1	10	RBE1-LNA1-2-Temp
22	RBE1	10	RBE1-LNA2-1-Temp
23	RBE1	10	RBE1-LNA2-2-Temp
24	RBE1	10	RBE1-LNA3-1-Temp
25	RBE1	10	RBE1-LNA3-2-Temp
26	RBE1	10	RBE1-LNA4-1-Temp
27	RBE1	10	RBE1-LNA4-2-Temp
28	RBE1	10	RBE1-PwrTemp
29	RBE1	10	RBE1-Bd Temp
30	RBE1	10	RBE1-AlgTemp1
31	RBE1	10	RBE1-AlgTemp2
32	RBE1	10	RBE1-AlgTemp3
33	RBE1	10	RBE1-AlgTemp4
DPU Flags, Counts, Contents			
34	DPU	12	LUT Echo: LUT & Addr
35	DPU	12	LUT Echo: RF State
36	DPU	8	DPU-Bmon-DPUE4
37	DPU	4	DPU-ResetCnt
38	DPU	12	CMD Rcvd Counter
39	DPU	12	CMD Error Counter
40		4	Spare
	Total:	400	Bits

400

50

Table 3-10: Housekeeping Packet #3		Item ID 0x93	
Item #	Subsystem	Size - bits	Description
1	DPU	4	Block Counter
RBE #2 Standard Housekeeping			

2	RBE2	8	RBE2-15VP
3	RBE2	8	RBE2-15VN
4	RBE2	8	RBE2-12VP
5	RBE2	8	RBE2-12VN
6	RBE2	8	RBE2-8VP
7	RBE2	8	RBE2-5VP
8	RBE2	10	RBE2-LNA1-1-Temp
9	RBE2	10	RBE2-LNA1-2-Temp
10	RBE2	10	RBE2-LNA2-1-Temp
11	RBE2	10	RBE2-LNA2-2-Temp
12	RBE2	10	RBE2-LNA3-1-Temp
13	RBE2	10	RBE2-LNA3-2-Temp
14	RBE2	10	RBE2-LNA4-1-Temp
15	RBE2	10	RBE2-LNA4-2-Temp
16	RBE2	10	RBE2-PwrTemp
17	RBE2	10	RBE2-Bd Temp
18	RBE2	10	RBE2-AlgTemp1
19	RBE2	10	RBE2-AlgTemp2
20	RBE2	10	RBE2-AlgTemp3
21	RBE2	10	RBE2-AlgTemp4

**RBE #3 Standard
Housekeeping**

22	RBE3	8	RBE3-15VP
23	RBE3	8	RBE3-15VN
24	RBE3	8	RBE3-12VP
25	RBE3	8	RBE3-12VN
26	RBE3	8	RBE3-8VP
27	RBE3	8	RBE3-5VP
28	RBE3	10	RBE3-LNA1-1-Temp
29	RBE3	10	RBE3-LNA1-2-Temp
30	RBE3	10	RBE3-LNA2-1-Temp
31	RBE3	10	RBE3-LNA2-2-Temp
32	RBE3	10	RBE3-LNA3-1-Temp
33	RBE3	10	RBE3-LNA3-2-Temp
34	RBE3	10	RBE3-LNA4-1-Temp
35	RBE3	10	RBE3-LNA4-2-Temp
36	RBE3	10	RBE3-PwrTemp
37	RBE3	10	RBE3-Bd Temp
38	RBE3	10	RBE3-AlgTemp1
39	RBE3	10	RBE3-AlgTemp2
40	RBE3	10	RBE3-AlgTemp3
41	RBE3	10	RBE3-AlgTemp4
42		20	Spare

Total:	400	Bits
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384

48

A 2 byte checksum is calculated for the entire block and inserted after the Radiometer science and telemetry data.

- d. ICDS to Service Platform 1553 bus**
- e. Service Platform to Mass Memory**
- f. Mass Memory to X-Band transmitter**
- g. S/P X-Band transmitter to ground site X-Band Rx antenna**
- h. X-Band Rx antenna to CCSDS de-formatter**
- i. CCSDS de-formatter to CONAE Data Archive and Distribution System**
- j. DADS to ADPS**
- k. Multiple downlink handling**
- l. Final format, Level 1a data**